The Environmental Data Services Company

CICERO

--

Community Initiative for Continuing Earth Radio Occultation

National Space Weather Workshop

--

May 3, 2017

Boulder, Co

Conrad C Lautenbacher, Jr

GeoOptics, Inc

Agenda

- Background
- Business Concept
- Advantages
- CICERO
- Why CICERO? -- Why NOW?
- The Market
- Opportunities

Background

- GeoOptics, Inc
  - Founded in 2006 by Thomas Yunck
    - Long time NASA researcher; GPS & RO Pioneer
  - Privately funded – commercial enterprise
  - Partnership with suppliers and manufacturers
- CICERO
  - Initial project
  - Large scale global RO constellation
  - Low Earth Orbit
  - International public-private “partnership”
  - Data sold
    - Subscriptions/license
    - Free for researchers

Business Concept

- Provide reliable, regular, lowest cost end user operational data
- Data initially sold to government agencies
  - By license/subscription negotiated for use and distribution
  - Commercial sector market follows
- Data Policy
  - Free to all researchers worldwide
  - Free to developing countries
  - Free to all countries on trial basis
  - Free to all countries once “worldwide license” fully subscribed
    - Single agency can secure worldwide license
- New efficiencies in production and operation
  - Commercial versus government business model
- Augmentation and continuation of COSMIC I, II
  - Includes perpetual maintenance and upgrade
- Self-supporting enterprise of scientists and users
  - shared design, evolution, and success

Advantages

- Development times significantly reduced
- Market Incentives drive down cost
- Costs distributed broadly worldwide
- Pay on delivery only; No public risk
- Payments with general vs capital funds
- Perpetual maintenance and upgrade
- Enhanced Scientist role
- Infusion path for new technologies

CICERO

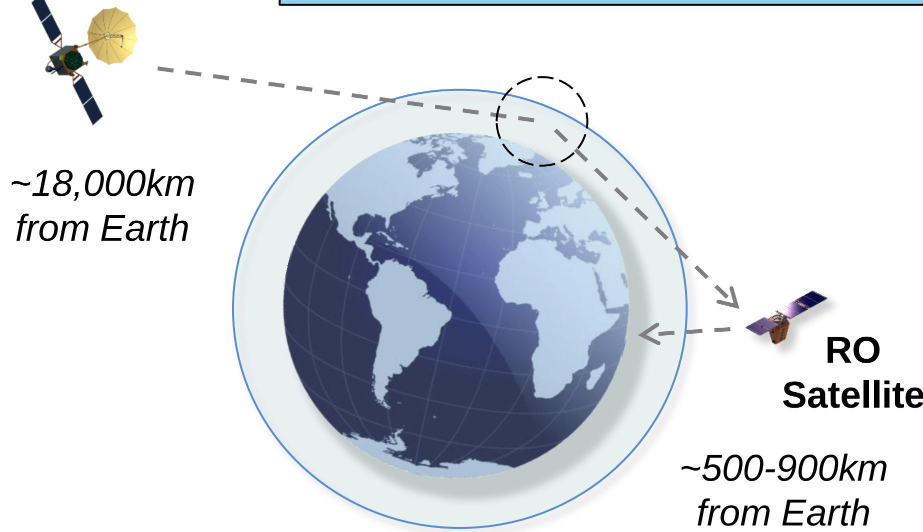
CICERO

- Nano Satellites
- 6 → 12 → 24 → 48 → ?
- Cion Receiver
- Ground Command & Control
- Data Processing
- Products
    - High Resolution Atmospheric Profiles
        - Bending Angle
        - Refractivity
        - Density
        - Pressure
        - Temperature/Moisture
        - Absolute Measurement Heights
    - Ionospheric Electron Density
    - Global Temporal & Spatial avgs
    - Global pressure contours, gradients & geostrophic winds
- Replenishment & Updating

COSMIC I

- Fully Successful RO Test
- Rapidly Reaching End of Life

Radio Occultation (RO)



COSMIC II

- Limited Satellite Number (12)
- Specified Lifetime
- CICERO data Interchangeable
    - Ground Processing
    - Distribution
    - NWP Use

Why CICERO? -- Why Now?

Current Weather Satellite System Unsustainable

- Small Satellite Numbers – one failure/delay is a disaster
- Inherent Cost Growth and Schedule Delays
  - Data gaps and continual crisis management mode
  - Satellite Cost growth crowds out other needs
- “Operational” Satellites that are really “Developmental”
  - Research to Operations gap
  - Too many instruments not “proven” in orbit
  - Excessive time from concept to operational use
- Poor Utilization of Commercial Capabilities
  - Only opportunities -- Build ever more costly Satellites
  - Communications and Imaging counter examples
    - Government not always most cost-efficient provider
- **New “Business” Model is Essential!**

Current Weather Satellite "Pipeline"

Research ⟷ Operations

Research:
- Government
- Academia
- Industry

Operations:
- Government
- Industry

NASA → NOAA

Terra -- Aqua → JPSS

MODIS* → VIIRS**

Time

- Cost Overruns
- Schedule Delays
- Potential Data Gap

$$$

- New Concept
- Demonstration
- 1 of a kind

What is missing??

- Reliable
- Continuous
- Timely
- Lowest Cost

Not

Goals

*Moderate Resolution Imaging Spectroradiometer
**Visible Infrared Imaging Radiometer Suite

Alternative Weather Satellite "Pipeline”

NASA → NOAA → NOAA

Research → Development Test & Evaluation → Operations

- Government
- Academia
- Industry

- Government
- Academia
- Industry

- Government
- Industry

Terra -- Aqua → “Free Flyer” → JPSS

MODIS* → “MODIS ++” → VIIRS**

- New Concept
- Demonstration
- 1 of a kind

- Technology
- Manufacturability
- Cost – Benefit
- Prove on Orbit

Time and Budget Flexible

- Reliable
- Continuous
- Timely
- Lowest Cost

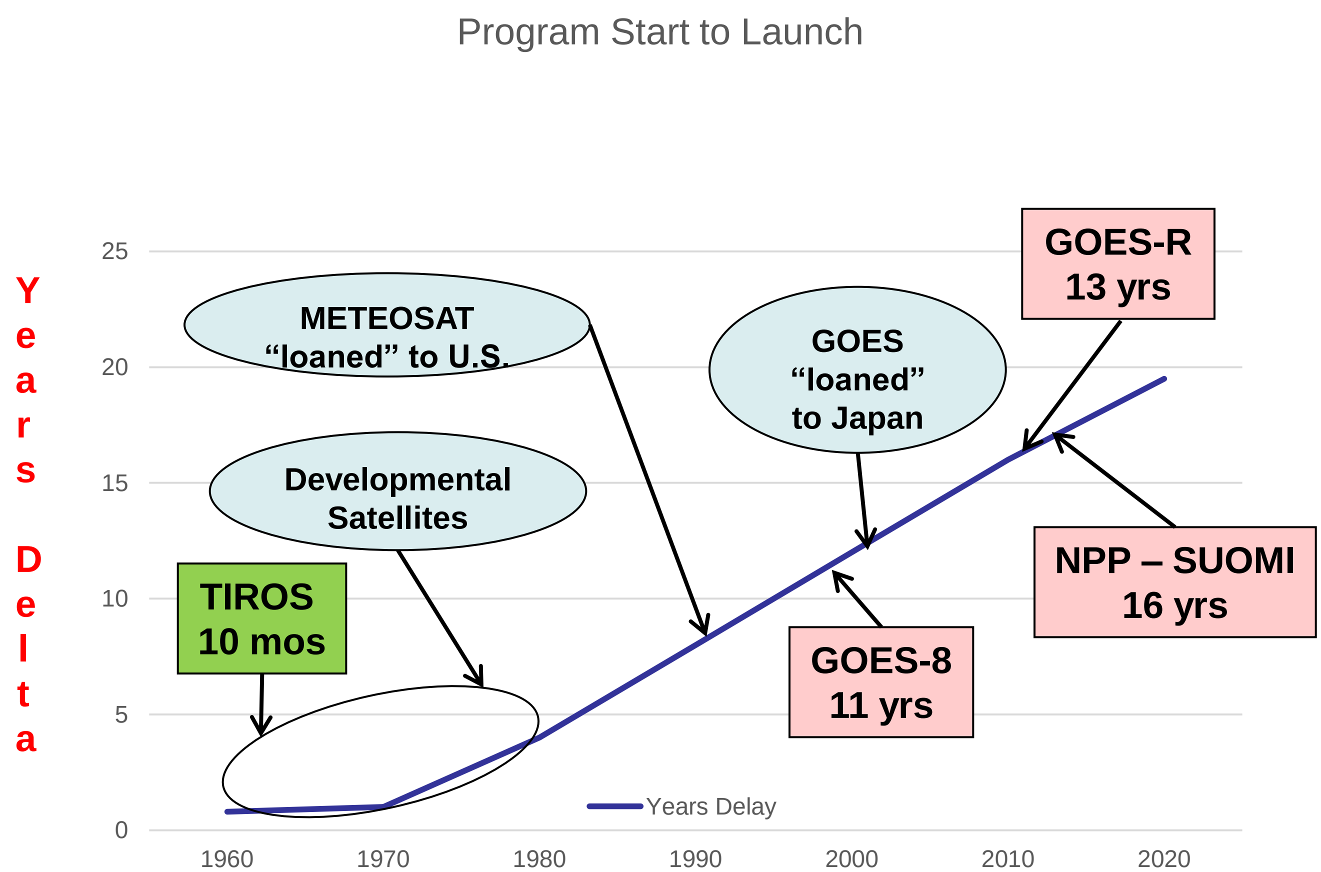
On Time and Budget

Options → Commercial Participation in RDT&E → Instrument licensed by government → Fixed Price Data Buys

*Moderate Resolution Imaging Spectroradiometer

**Visible Infrared Imaging Radiometer Suite

Space Segment Issues



- Small "Operational" Satellite Numbers – 1 loss a disaster
- Operational Satellites that are really "Developmental"
- Inherent Cost Growth and Schedule Delays

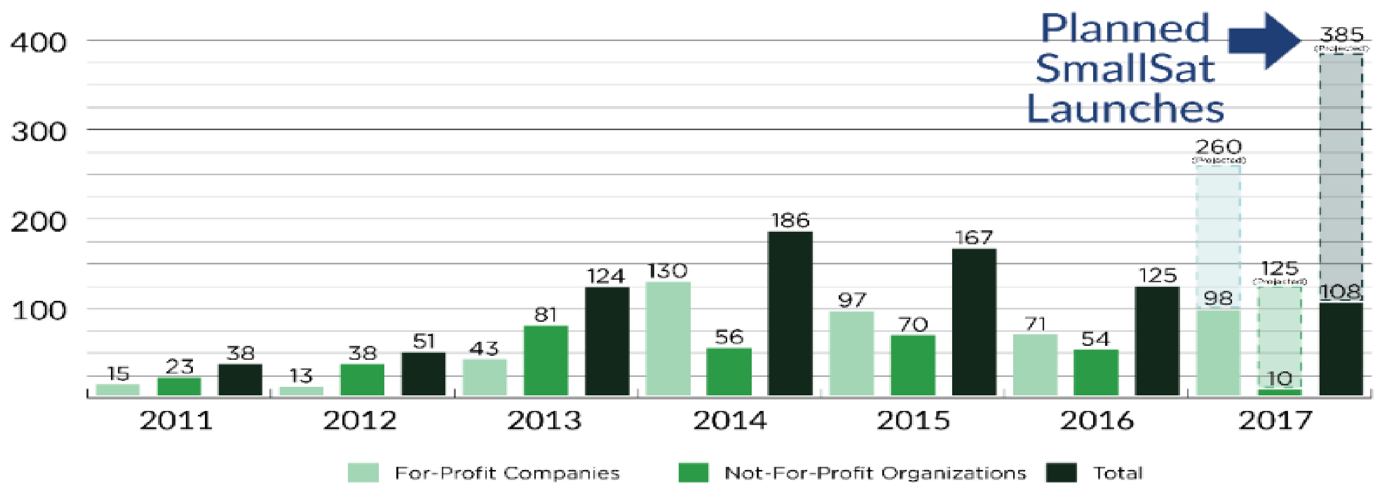
Why CICERO? -- Why Now?

Evolution of Space Applications

- Communications
  - Now dominated by commercial sector
- Imaging
  - Being taken over by commercial applications
- Earth Observation
  - Next large commercial entry

Global Space Market now 76% Commercial

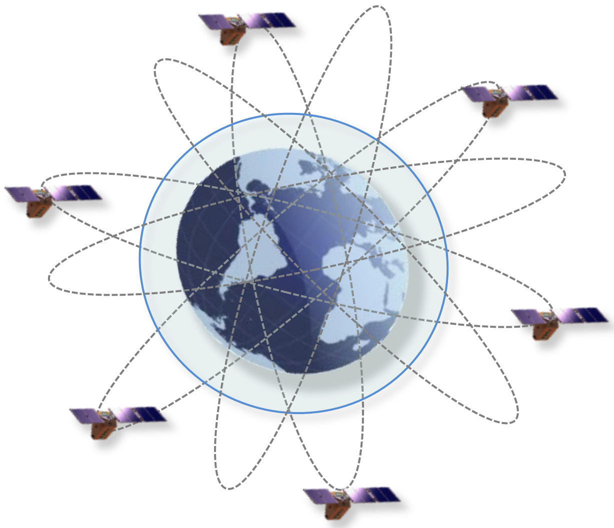
Small & Nano Sat Entry



NewSpace Global Newsletter April 17, 2017

The Future!

CICERO



Public - Private Partnering

--

Self Supporting Enterprise
of
Scientists and Users

- – With many thanks for your attention and interest!
- – And a sustainable future for all!

Conrad C Lautenbacher, Jr.

The Environmental Data Services Company

Back-up Slides

The Future

Sample Projects in the RDT&E pipeline today

- Microwave Atmospheric Satellite (NanoRacks-MicroMAS)
- Microwave Radiometer Technology Acceleration (MiRaTA)
- Compact Infrared Radiometer in Space (CIRiS)
- CubeSat Infrared Atmospheric Sounder (CIRAS)
- Microwave Atmospheric Sounder On CubeSat (MASC)*
- Snow and Water Imaging Spectrometer (SWIS)*
- Precipitation Profiler_RainCube
- ………. etc.

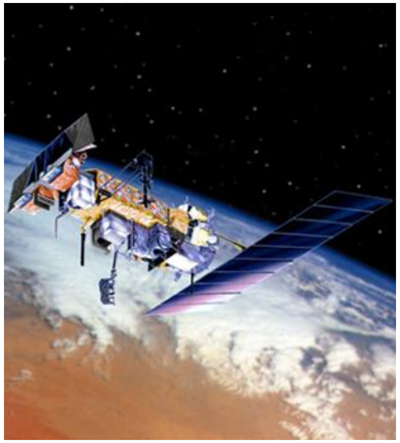
Current U.S. Weather Space Segment

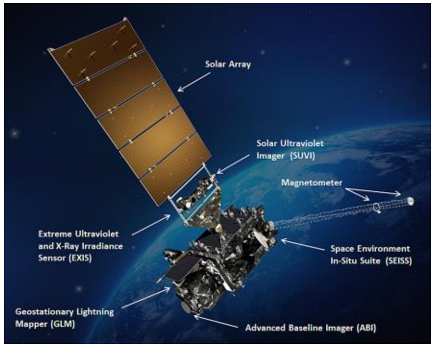
LEO

- Best Resolution
- 90-95% of NWP Data

GEO

- Continuous “Stare”
- Storm Warnings





POES 19

1. AVHRR
2. AMSU(2)
3. HIRS
4. MHS

JPSS-1

1. CRiS
2. VIIRS
3. OMPS
4. ATMS
5. CERES

GOES 15

1. Imager
2. Sounder
3. SXI
4. SEM

GOES-R

1. ABI
2. GLM
3. SUVI
4. EXIS
5. Magnetometer

Redundancy?

~3 Quantity 2

GeoOptics

The Global Space Economy

Steady Growth!

Sector	$B	%
Commercial Products & Services	116	6
Commercial Infrastructure & Support	110	11
U.S. Government Space Budgets	48	0
Non U.S. Government Space Budgets	31	1
*Total	**$304B**	7

Stagnant!

U.S. Government	
NASA	**$18B**
(NOAA	$5B)
NESDIS	**$2B**
USAF	--**

*http://www.spacefoundation.org/programs/research-and-analysis/space-report/20-space-economy

**Money in budget for weather satellite replacement studies only

Commercial Satellite Communications

Continent	No. Companies
Asia/Oceana	31
Europe	27
North America	23
South America	5
International	2
Total*	**88**

Market Size	$B
Total Space	304
Satellite Communications	**149*****

GSA Listings**

- Interactive Voice, Video, or Data Networks for applications such as Distance Learning and Telemedicine
- Broadcast Satellite Services with network operations and management support
- Network Diversity/COOP networks such as VSAT backup networks
- Long duration, baseline communications services and infrastructure to support enduring user requirements
- Short duration communications services to support temporary user requirements

- Satellite Communications
  - Majority commercial****
    - 54% of all satellites in orbit (1000+ Dec 2012) are communications
    - 70% of those are Commercial
  - Bought as a service
  - Governments
    - National Defense Agencies
    - Services not satellites
  - Cost efficient
  - Reliable
  - Technically complex

*http://en.wikipedia.org/wiki/List_of_communication_satellite_companies

**http://www.gsa.gov/portal/ (U.S. government purchasing agency)

*** SWAG from Space Foundation & Satellite Industry Assoc. data

**** http://www.sia.org/wp-content/uploads/2013/06/2013_SSIR_Final.pdf

Commercial Satellite Imaging

Market Size	$B
Total Space	304
Satellite Imaging	**1.4***

$3.8B
In 2018**

Imaging – 9 Companies

(Optical and Radar)

- TerraSAR
- RapidEye
- InfoTerra
- Digital Globe / GeoEye
- Antrix
- Radarsat
- SkyBox
- Spot Image
- Skymed

*Euroconsult 2012 and company sources

** http://www.transparencymarketresearch.com/commercial-satellite-imaging-market.html

Commercial Satellite Imaging & Non-imaging

Market Size	**$B**
Total Space	304
Satellite Imaging & Non-Imaging	**11.4***

Global Meteorological and Environmental Data Market

Imaging – 9 Companies (Optical and Radar)
- TerraSAR
- RapidEye
- InfoTerra
- Digital Globe / GeoEye
- Antrix
- Radarsat
- SkyBox
- Spot Image
- Skymed

$1.4B

Non-imaging

- Weather
- Climate
- Space Weather

$10.0B

*Euroconsult 2012 and company sources

Human Capital Issues

- Aging Work Force
  - Pioneers are retiring
  - Challenge and Opportunity

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather its opponents eventually die, and a new generation grows up that is familiar with it. — Max Planck *Scientific Autobiography and Other Papers*, trans. F. Gaynor (1950), 33.

- Technology Moving Rapidly
- New Space Business Model(s)
  - “Battle Stars” vs. “Cellularized” constellations
  - Include Commercial Expertise and Experience

Opportunities

Expanded Public -- Private Sector “Partnerships”

- Fewer Government Dollars
  - Agencies looking for help to meet requirements and funding
    - Many agency budgets labor intensive (fewer employees)
  - Mutual Support
  - Demand increasing from both government and private sectors
  - U.S. NWS already including as part of future budget strategy
  - Potential New Products and Services
  - Some Agency Needs could be met by contracted services
  - Also by Data Purchases
    - Commercial Radio Occultation (RO) constellation
- Increased public – private dialogue needed
  - Cooperative and Mutually Supporting
  - Division of Public and Private Workload
  - Meeting Needs at Maximum Cost-Efficiency